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Paraleuctra (Insecta: Plecoptera: Leuctridae) from Japan, with Taxonomic Notes on the Japanese Leuctridae

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Eight species of the genus *Paraleuctra* are recognized in Japan, six of them being described as new herein: *P. ezoensis* from Hokkaido and *P. ambulans*, *P. similis*, *P. hokurikuensis*, *P. angulata*, and *P. concava* from Honshu. An apterous and a short-winged species are included. A neotype is designated for *Leuctra okamotoa* Claassen, 1936; this species is now transferred from *Rhopalopsole* to the present genus and is regarded as a senior subjective synonym of *P. gracilis* Kawai, 1967. *Paraleuctra cercia* (Okamoto, 1922) is redescribed and regarded as a senior subjective synonym of both *P. forficularis* (Okamoto, 1922) and *L. higashiyamae* Kohno, 1965. *Paraleuctra elongata* Kawai, 1967 is transferred to *Rhopalopsole*, and *P. nipponica* (Okamoto, 1922) and *Rhopalopsole gifuensis* Kohno, 1965 are transferred to *Perlomyia*. A key is provided for Asian species of *Paraleuctra*.

Key Words: Plecoptera, Leuctridae, *Paraleuctra*, neotype, new combination, new synonymy, new species, Japan.

Introduction

The Japanese Leuctridae were first studied by Okamoto (1922), who described six species: *Leuctra abdominalis*, *L. cercia*, *L. forficularis*, *L. nipponica*, and two new species of *Rhopalopsole*. Claassen (1936) renamed *L. abdominalis* as *L. okamotoa* because of homonymy. Kohno (1965) added two new species, *L. higashiyamae* and *Rhopalopsole gifuensis*. Then Kawai (1967) transferred *L. cercia* and *L. nipponica* to *Paraleuctra* and *L. okamotoa* to *Rhopalopsole*. In the same paper, he also described four new species, *Paraleuctra elongata*, *P. gracilis*, *Rhopalopsole parva*, and *R. amamiensis*, and newly recorded a Taiwanese species, *R. dentata* Klapálek, 1912, from Honshu, Japan. Kawai (1968) described a new *Rhopalopsole* from Yaeyama Islands. Kawai (1976) listed five species including *L. forficularis* under *Paraleuctra* and seven under *Rhopalopsole* while treating the two species of Kohno (1965) as *nomina nuda*. Zwick (1977) subsequently defined *Paraleuctra*, *Rhopalopsole* and *Perlomyia* based on Himalayan leuctrids and transferred a Japanese species, *R. parva*, to *Perlomyia*.

The genus *Paraleuctra*, which was proposed by Hanson (1941), is composed of small, stick-like stoneflies including closely similar species; and it presently consists of 20 species from Asia and the Nearctic region. However, taxonomic study of the Japanese *Paraleuctra* has been very insufficient and not a few species still remain undescribed. In this study, six species are newly described and redescriptions are given for two known species with such acts of zoological nomenclature as designation of neotype and proposal of new synonymies. A key to whole the Asian species is also provided herein. As shown in the key, these species can be categorized into three groups, the groups of *P. cercia*, *P. purcellana* (Neave, 1934), and *P. occidentalis* (Banks, 1907), according to the morphological similarities of their terminalia with the exception of *P. ambulans* sp. n. and *P. divisa* (Hitchcock, 1969), both of which are not assigned to any groups.

Besides the genus *Paraleuctra*, the Japanese species of the family Leuctridae have also been little studied, and still posed problems regarding misidentifications and proper generic attribution of species as mentioned by Nelson (1977). In the last part of this study, generic assignments are discussed for three Japanese leuctrids and new combinations are proposed.

Materials and Methods

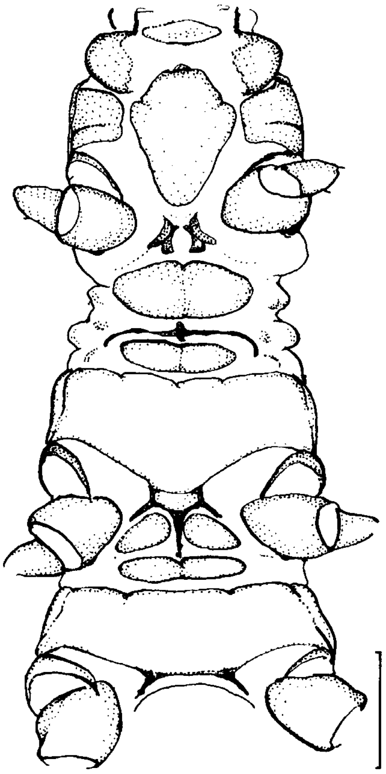
More than 350 specimens of *Paraleuctra* collected from Japan by the author himself and stored in 70–80% alcohol were examined. The collection of Dr. Shigekazu Uchida at the Lake Biwa Museum (LBM), Kusatsu, was also studied, and additional materials including examples of Nearctic species were provided by individuals mentioned in the acknowledgements. The holotype of *Paraleuctra gracilis* Kawai, 1967 and the specimens studied by Kawai (1967) were borrowed from the Biological Laboratory, Nara Women's University, Nara. Unfortunately, the syntypes of three species described by Okamoto (1922) could not be found. For the illustrations of every newly described species, a pair of specimens was selected among the paratypes collected from the type locality or its vicinities. Redescriptions of *P. okamotoa* (Claassen, 1936) and *P. cercia* (Okamoto, 1922) are based on newly collected topotypic materials as well. Variation in the structure of the terminalia is noted if it is remarkable. All holotypes and some of the paratypes of the new nominal species and the neotype of *P. okamotoa* are deposited in the Natural History Museum and Institute Chiba (CBM), Chiba. Other specimens are in my personal collection.

The morphological terms follow recent articles (e.g., Zwick 1973; Nelson 1977; Harper and Wildman 1985). The paraprocts are described as though they are in their normal developing position (reversed with respect to the directions of Figs 16, 30, 34–35, 38, 41, and 44), although the direction reverses at copulation.

Paraleuctra ezoensis sp. nov.

(Figs 1, 2, 4–9)

Description. Wings shortened; forewings darker and slightly thicker in anal areas than elsewhere (Fig. 2); hind wings shorter than forewings but extending beyond tips of latter at rest, reaching region of segments 6–9. Body generally brown, with darker markings. Anterior margins of meso- and post-basisternum even; prothoracic furcasternum adjacent to basisternum (Fig. 1).



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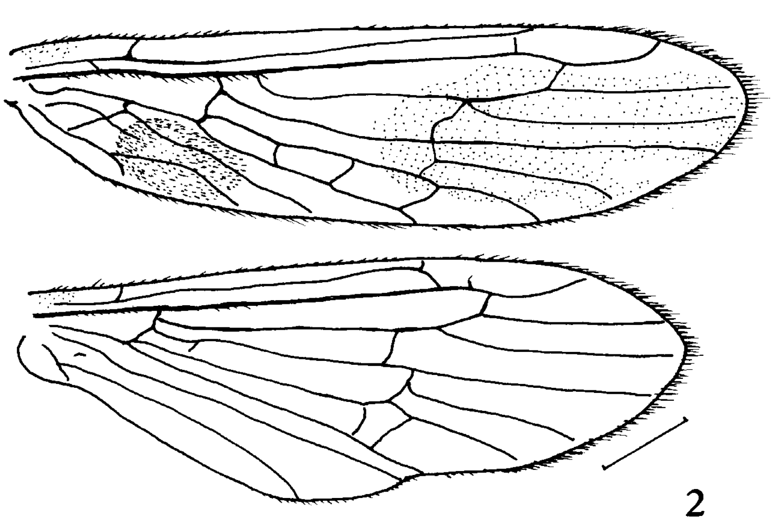

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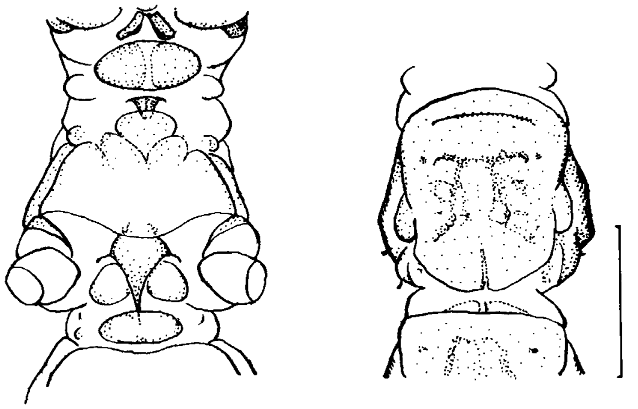

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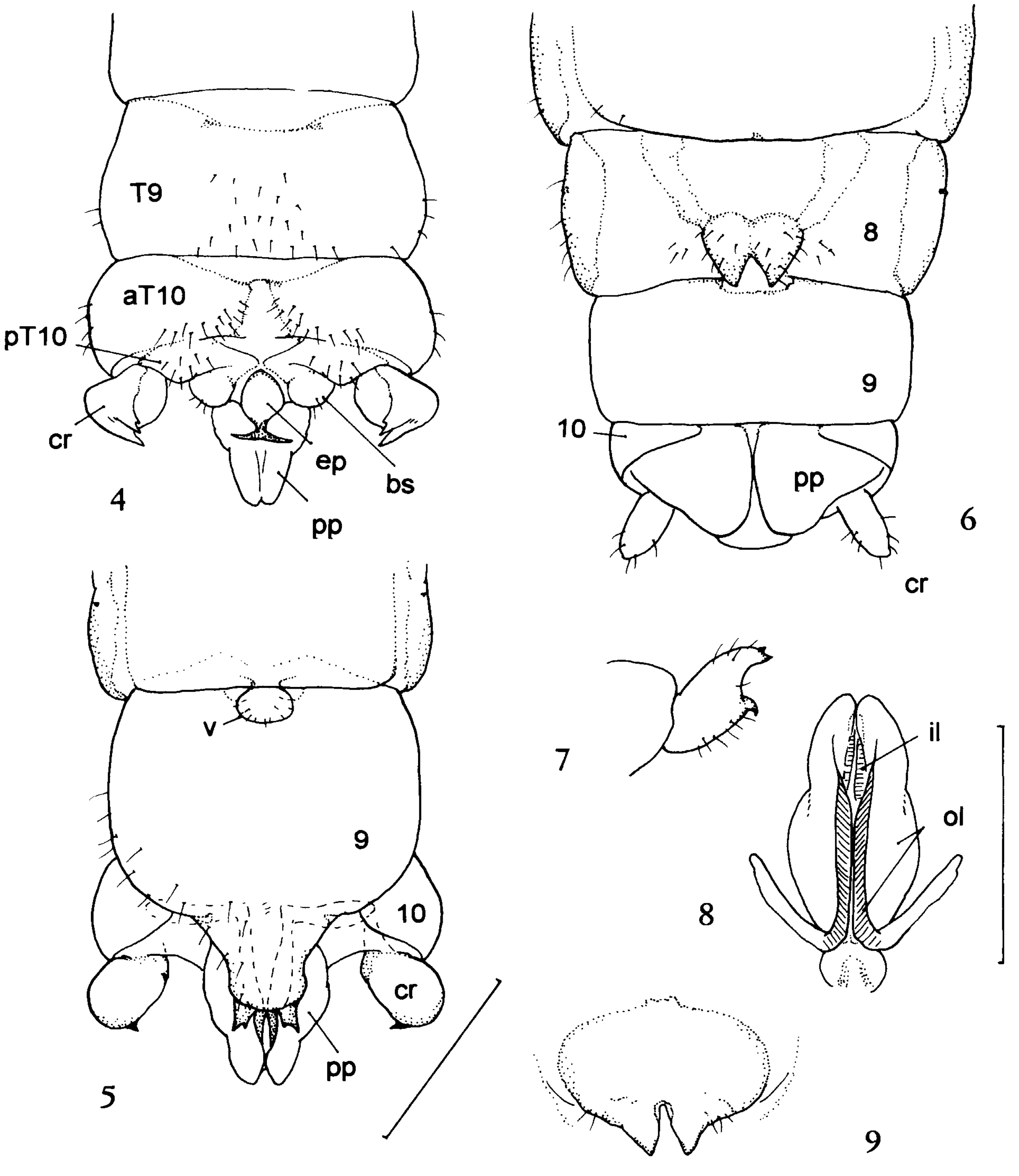
Figs 1–2. *Paraleuctra ezoensis*, female from Shizunai Town, Hokkaido: 1, thorax, ventral view; 2, right wings. Fig. 3. *Paraleuctra ambulans*, female from Torigoe Vill., Ishikawa Pref.: 3, mesothorax, ventral (left) and dorsal views. Scales: 0.5 mm.

Male. Length of body 5.0–5.5 mm; length of forewings 2.5–3.0 mm. Abdominal tergites and sternites fully sclerotized. Segment 9 ring-like; sternite with round vesicle in anterior margin, hind margin protruding medially and bent upward to rounded tip bearing pair of bidentate projections (Fig. 5). Tergite 10 consists of pair of large, anterior plates and small, posterior, transverse plates (Fig. 4). Anterior part of tergite depressed along narrow cleft along midline. Posterior part of tergite extended to rounded basal sclerites of epiproct; epiproct robust at base, apex forked outward to pointed tips (Fig. 4). Cercus short and stout, membranous on inner side, with 3 tips: acute ventromedial projection and dorsal apex ending in 2 small points (Fig. 7). Medial parts of paraprocts forming robust, membranous probe: inner lobes covered by inner parts of outer lobes and forming pair of slender rods along midline; outer lobes stick-like at base, sclerotized along only the lateral portions, and extended dorsomedially (Fig. 8). Probe weakly compressed at about distal third (Fig. 8).

Female. Length of body 5.5–7.0 mm; length of forewings 3.0–4.5 mm. Abdominal tergites 1 and 2 sclerotized medially and along their anterior margins; tergites 3 to 8 widely membranous except for linearly sclerotized areas along midline and lat-



Figs 4–9. *Paraleuctra ezoensis*, 4–8, male and female from Shizunai Town; 9, female from Sapporo, Hokkaido: 4 and 5, male terminalia, dorsal and ventral views, respectively; 6, female terminalia, ventral view; 7, left cercus, profile; 8, paraprocts, upper face; 9, female subgenital plate. Abbreviations: bs, basal sclerite of epiproct; cr, cercus; ep, epiproct; il, inner lobe of paraproct; ol, outer lobe of paraproct; pp, paraproct; T, tergite (aT and pT, anterior and posterior tergites); v, vesicle; 8–10, 8th to 10th segments. Scales: 0.5 mm; figures are illustrated at the same magnification except Figs 7 and 8.

eral margins; tergites 9 and 10 mostly sclerotized. Sternite 8 forming large subgenital plate in middle, which is ended in two tapered protrusions (Fig. 9); sclerotization and shape of subgenital plate variable, i.e., sternite 8 often only sclerotized posteriorly, usually forming undeveloped subgenital plate (Fig. 6). Cerci and paraprocts normal (Fig. 6).

Remarks. This species is similar to *P. andersoni* Harper and Wildman, 1985 and *P. purcellana* in having a ring-shaped male segment 9 with a ventromedial projection, male cerci with bifurcate apices of the upper arms, and a broad membranous field in the female sternite 8. This species and *P. andersoni* are also similar in having the male sternite 9 with two bidentate projections on a prominent apex. The new species is separated from *P. andersoni* by the following features: (1) the female subgenital plate not being prolonged, (2) the bifurcate epiproct, and (3) the shortened wings. The female closely resembles that of *P. purcellana* in the subgenital plate, but differs in having less developed projections of that plate.

Within the family Leuctridae, only some European species of *Leuctra* are known to have short-winged (e.g., Ravizza 1978; Ravizza and Ravizza-Dematteis 1992) or apterous forms (e.g., Braasch and Joost 1977; Sivec 1982; Kacanski and Zwick 1970; Vinçon and Pardo 1994). *Paraleuctra* species that lack fully developed wings include only this species and *P. ambulans* sp. nov., although they are not closely related according to their terminalia.

Biological notes. This species was discovered near small mountain rivulets.

Etymology. The specific epithet is based on an ancient name for Hokkaido, Ezo.

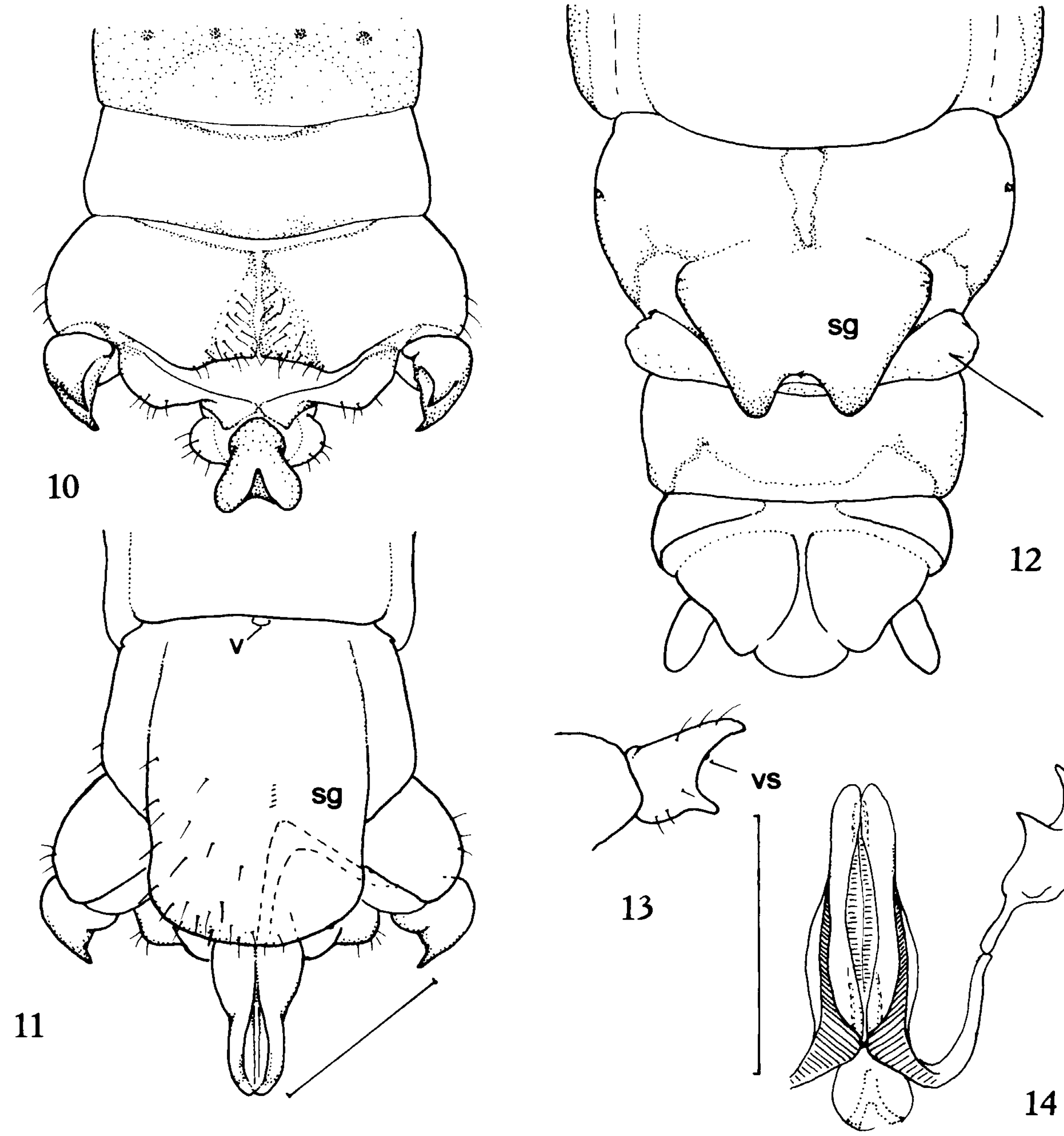
Type specimens. *Holotype.* ♂ (CBM-ZI: #76655), Hokkaido, Sapporo City, Misumai, 3.v.1992, N. Kuhara. *Paratypes.* [Hokkaido] 2 ♀ (CBM-ZI: #76656-7), collected with holotype; 1 ♂ 1 ♀ (CBM-ZI: #76658-9), Shizunai Town, near Petegari Lodge, Koikakusushibecchari River, 6.vi.1992; 2 ♀, Shizunai Town, Shizunai River, Takami Dam, 6.vi.1992; 1 ♂ 2 ♀, Yûbari City, Mt. Yûbari, 12.vii.1992, N. Kuhara; 2 ♀, Yûbari City, Akashi, 7.vi.1992; 1 ♂ 1 ♀, Shikaoi Town, near Shikaribetsu Lake, 10.vi.1992; 2 ♀, Urakawa Town, Hidakahorobetsu River, 6.vi.1992.

Paraleuctra ambulans sp. nov.

(Figs 3, 10–14)

Description. Apterous; pterothoracic tergites with small wing-pad on each lateral margin (Fig. 3); body generally brown, with darker markings. Spinasternite without lateral arms. Anterior margins of mesobasisternum divided by presternum (Fig. 3). Prothoracic furcasternum adjacent to basisternum.

Male. Length of body 5.5–6.0 mm. Abdominal tergites and sternites fully sclerotized, except posterior area of tergite 8. Sternite 9 with quadrate subgenital plate with rounded angles, hind margin almost even; small vesicle present (Fig. 11). Anterior part of tergite 10 narrowly cleft and depressed along midline; posterior part of tergite forming pair of transverse lobes (Fig. 10). Epiproct expanded, leaf-like in shape; apex tapered and recurved forward. Cercus forked into 2 pointed apices dorsally and ventrally, dorsal prong longer than ventral one; small bulge (vestige of a more distal segment) present at base of lower face of ventral branch (Fig. 13). Paraprocts forming an elongate median probe and long outer arms; probe mostly mem-



Figs 10–14. *Paraleuctra ambulans*, male and female from Ishikawa Pref.: 10 and 11, male terminalia, dorsal and ventral views, respectively; 12, female terminalia, ventral view; 13, left cercus, profile; 14, paraproct and left cercus, upper face. Arrow in Fig. 12 indicates unidentifiable plug occupying vulva. Abbreviations: sg, subgenital plate of male and female; v, vesicle; vs, vestige of more distal segment of cercus. Scales: 0.5mm; figures are illustrated at the same magnification except Figs 13 and 14.

branous dorsally, sclerotized ventrally from base to apico-lateral margins; inner lobes forming pair of slender rods internally (Fig. 14).

Female. Length of body 6.0–7.5 mm. Abdominal tergite 1 fully sclerotized; tergites 2 to 8 with membranous field on either side of large median sclerite. Subgenital plate gently expanded posteriorly, with blunt posterior protrusion on either side of midline (Fig. 12). Cerci and paraprocts normal (Fig. 12).

Remarks. This species is easily discriminated from all other species of *Para-*

leuctra by the apterism and in having peculiar features in both the male and female terminalia, e.g., a reduced vesicle, leaf-shaped epiproct, and prolonged female subgenital plate. This species appears to be related, though not closely, to *P. cercia* and its relatives, since they all have deeply forked cerci in the males.

Biological notes. This species was discovered on snow near small streams. Some female specimens have a pale brown plug that occupies the opening of the vulva and reaches to both lateral margins of sternite 8 (Fig. 12). The plug can easily be removed after clearing with warm KOH solution. If it is a spermatophore, it appears capable of preventing succeeding copulations, although this has not been proven.

Etymology. The specific epithet is based on the walking habit of the adults, from the Latin *ambulare*: to walk.

Type specimens. *Holotype.* ♂ (CBM-ZI: #76660), Honshu, Ishikawa Pref., Torigoe Village, Kazuse, 250m, 5.iii.1993, T. Shimizu. *Paratypes.* Honshu, Ishikawa Pref., Torigoe Village, 2 ♂ 10 ♀ (CBM-ZI: #76661-72), collected with holotype; 2 ♂ 3 ♀, Ishikawa Pref., Torigoe Village, Dainichi River, 200m, 4–5.iii.1993.

Paraleuctra cercia (Okamoto, 1922)

(Figs 15–26)

Leuctra cercia Okamoto, 1922, p. 39, pl. VI, figs 3–5. Syntypes ♂ ♂ ♀ ♀ (missing), Sapporo, Hokkaido, Japan.—Claassen, 1940, p. 76; Kohno, 1957, p. 5; Kohno, 1964, p. 33.

Leuctra forficularis Okamoto, 1922, p. 39, pl. VI, figs 3–5. Syntypes ♂ ♂ ♀ ♀ (missing), Sapporo, Hokkaido, Japan.—Claassen, 1940, p. 78; Kohno, 1957, p. 5; Kohno, 1964, p. 33; Illies, 1966, p. 464, noted as *nomen dubium*; Kawai, 1967, p. 34. **Syn. nov.**

Leuctra higashiyamae Kohno, 1964, p. 33, *nomen nudum.*

Leuctra higashiyamae Kohno, 1965, p. 41.—Illies, 1966, p. 464, noted as *nomen nudum*; Kawai, 1976, p. 39, noted as *nomen nudum*. **Syn. nov.**

Paraleuctra cercia: Kawai, 1967, p. 36, fig. 19 A–D.—Zhiltzova, 1976: p. 60, fig. 2.

Paraleuctra forficularis: Kawai, 1976, p. 7.

Okamoto (1922) described *L. forficularis* together with *L. cercia* in his monograph on the Japanese Plecoptera and wrote that the two species were separable by differences in the shape of the male subgenital plate. He also stated that the latter species lacks a vesicle on sternite 9, whereas the former species has one. The illustrated female of *L. forficularis* closely resembles those presently available, but male specimens that completely agree with the original description of *L. forficularis* have never been found. My examination of specimens from Japan suggests that Okamoto (1922) erred in recognizing small-sized specimens from Hokkaido as a different species, *L. forficularis*. The vesicle of such males is small and often invisible, being covered by the preceding segment.

Although *L. higashiyamae* has been treated as an unavailable name, the species is here regarded as having been validated by Kohno (1965) after she first proposed it as a *nomen nudum* in a checklist (Kohno 1964). The 1965 publication, in an illustrated book on Japanese insects, includes a brief description, which may be regarded as a diagnosis. The illustration of the male terminalia agrees with that of the present material of Paraleuctra cercia in having distinctly forked cerci.

Description. Macropterous; body generally brown, but with darker markings. Size variable as given below, and wings sometimes slightly shortened (apex near tip of body at rest) in some of specimens from Hokkaido.

Male. Length of body 5.5–8.0 mm; length of forewings 5.0–8.0 mm. Abdominal tergites and sternites fully sclerotized except for posterior area of tergite 8. Sternite 9 with a transverse vesicle. Subgenital plate widely protruded posteriorly, hind edge weakly concave medially. Anterior part of tergite 10 divided and depressed along midline (Fig. 15); posterior part of tergite slender, possessing angulate corners on both inner and outer margins. Epiproct hairy, roundly expanded in basal half; apex slender, recurved forward (Figs 17, 18). Cercus with large bulge at base of dorsal surface and two pointed distal apices dorsally and ventrally; dorsal branch with small bulge (vestige of a more distal segment) on posterior side (Figs 16, 19–20); ventral branch with small bulge on inner side (Fig. 16). Paraprocts forming slender, membranous probe and outer arms; probe gently swollen in apical half, widely sclerotized along lower face in basal half, and laterally sclerotized in distal area (Fig. 16). Inner lobes extending internally almost to apex of the probe.

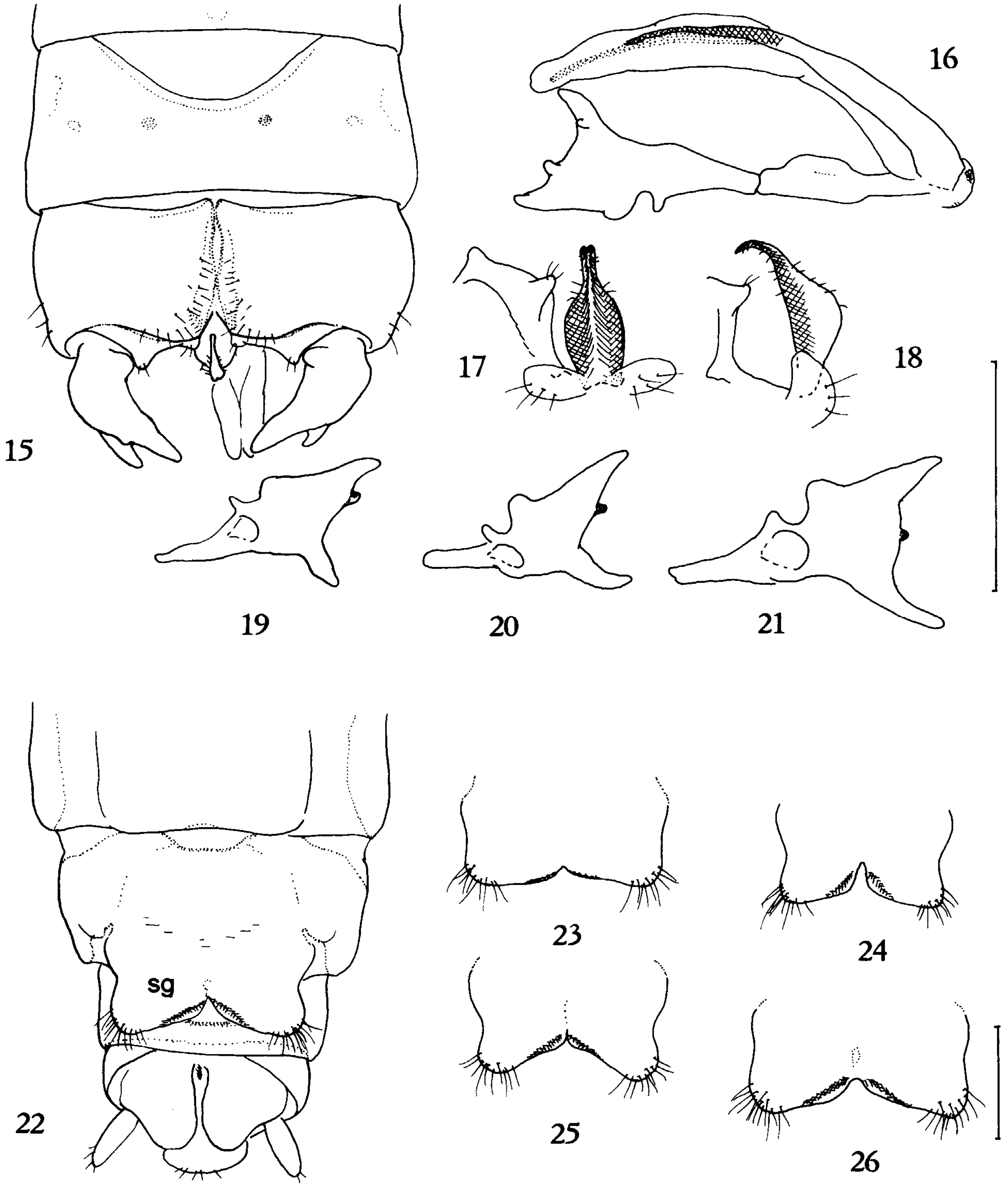
Female. Length of body 6.5–9.0 mm; length of forewings 5.5–9.0 mm. Abdominal tergites 1 to 3 fully sclerotized; tergites 4 to 8 membranous except for wide, sclerotized area along the midline and on either side. Subgenital plate strongly sclerotized, expanded posteriorly over the following segment; hind margin wide, expanded to roundly angulate corners, sharply notched in middle (Figs 22–26). Sternite 9 broadly membranous in anteromedial part. Cerci and paraprocts normal (Fig. 22).

Variation. Some female specimens from Hokkaido differ from the other specimens in having only tergites 1 and 2 fully sclerotized and tergite 3 with membranous fields like the succeeding segments. They usually have slightly shorter wings than the others, and the extent of the membranous fields in tergite 3 is often broader. The female subgenital plate is rather variable in shape (Figs 22–26).

Remarks. This species resembles *P. forcipata* (Frison, 1939), *P. orientalis*, *P. sara* (Claassen, 1936), *P. tetraedra*, *P. vershina* Gaufin and Ricker, 1974, and *P. zapekinae* Zhiltzova, 1974. All of them are similar in their male and female terminalia. They have deeply forked cerci with long ventral arms, an elongate paraproct without a distinct expansion, a male subgenital plate with a deeply excavated hind margin, and a female subgenital plate that is strongly sclerotized and divided in the middle of the hind margin.

Most of the other males are separable from that of *P. cercia* by slight differences in the shape of the cerci, e.g., *P. tetraedra*, *P. vershina*, *P. zapekinae*, and maybe *P. orientalis* lack a projection on the ventral arm of the cercus. *Paraleuctra forcipata* is separable from *P. cercia* by the larger extent (about 2/3 in dorsal view) of the distal membranous portion of the paraprocts, and *P. sara* by the lesser extent (about 1/3 in dorsal view) of the distal membranous portion.

Although females are difficult to distinguish by the shape of the subgenital plate, the female of *P. cercia* is separable at least from those of *P. orientalis* and *P. tetraedra* by this feature. The female of *P. cercia* has an angulate hind margin, while this margin in the latter two species is more or less roundly expanded. The subgenital plates of *P. cercia* and *P. zapekinae* are different in the angles of the pos-



Figs 15–26. *Paraleuctra cercia*, 15–18, 20, and 22, male and female from Sapporo, Hokkaido, and 19, 21, and 23–26, specimens from Honshu: 15, male terminalia, dorsal view; 16, paraproct, profile and left cercus, inner side; 17 and 18, epiproct, lower face and profile, respectively; 19–21, cercus, variation; 22, female terminalia, ventral view; 23–26, subgenital plate, variation. Abbreviations: sg, female subgenital plate (Fig. 16 illustrated upside-down, the upper side being ventral in the adult). Scales: 0.5 mm.

terolateral margins according to Zhiltzova and Zapekina-Dulkejt (1986).

Material examined. [Hokkaido] Akan Town, Ponchûrui River, 9.vi.1992, 2 ♂ 5 ♀; Obihiro City, Tottabetsu River, 10.vi.1992, 1 ♂ 2 ♀; Mashike Town, Mt. Shokanbetsu, 14.vi.1992, 1 ♂; Sapporo City, Nakayama Pass, 29.vi.1992, 2 ♂. [Honshu] Aomori Pref., Aomori City, Hakkôda Mts., Tashiro-daira, 1.vi.1990, 1 ♂ 4 ♀; Yamagata Pref., Atsumi Village, Mt. Atsumi, 24.iii.1993, 8 ♂ 14 ♀; Fukushima Pref., Inawashiro Town, headwaters of Oda River, 4.v.1991, 1 ♀; Tochigi Pref., Motegi Town, Motegi, 29 30.vi.1993, 2 ♂ 2 ♀; Kanagawa Pref., Yokosuka City, Sawayama-no-ike, 21.iii.1992, 4 ♂ 2 ♀; Ishikawa Pref., Kaga City, Daishôji, Mitani, 22.iv.1991, 4 ♂ 10 ♀; Yamanashi Pref., Sutama Town, Mikado, 3.v.1990, 1 ♂ 1 ♀; Nagano Pref., Otari Village, Otari Spa, 5.vi.1994, 1 ♂; Gifu Pref., Fujihashi Village, Kôkura Pass, 3 ♂ 13 ♀; Shizuoka Pref., Haruno Town, Hanajima, 330m, 14.iii.1993, 1 ♀; Mie Pref., Misugi Village, Hirakura, 400 m, 24.iii.1992, 1 ♂ 2 ♀; Nara Pref., Higashiyoshino Village, Ohmata, 31.iii.1993, 1 ♂ 1 ♀; Kyoto Pref., Kyoto City, Kibune River, 1–2.v.1984, Y. Takemon (emergence trap), 1 ♀; Hyogo Pref., Niimiya Town, Ichinoho, 2.iii.1993, 2 ♂ 2 ♀; Okayama Pref., Kawakami Village, Hiruzen Mts., 450 m, 2.v.1992, 1 ♂; Tottori Pref., Kôfu Town, Daisen Mts., Kagamiganaru, 900 m, 2.v.1992, 2 ♀; Shimane Pref., Yoshida Village, Kuniôhara, 7000 m, 1.v.1992, 3 ♀. [Shikoku] Tokushima Pref., Kizawa Village, Tsurugi Super Forest Road, 1400 m, 3.vi.1991, 2 ♂ 2 ♀; Kochi Pref., Nishitosa Village, headwaters of Kuroson River, 1.iv.1991, 3 ♂ 5 ♀. [Kyushu] Miyazaki Pref., Kitagô Town, Inohae Valley, 5.iii.1994, 10 ♂ 5 ♀; Kagoshima Pref., Uchinoura Town, Samuta Valley, 5.iii.1994, 2 ♂ 1 ♀.

Paraleuctra okamotoa (Claassen, 1936), comb. nov.

(Figs 27–31)

Leuctra abdominalis Okamoto (nec Stephens), 1922, p. 39, pl. VI, fig. 6.—Syntypes: ♂ ♂ ♀ ♀ (probably lost) from Sapporo, Hokkaido, and Yoshino, Honshu, Japan.

Leuctra okamotoa Claassen, 1936, p. 623.—Claassen, 1940, p. 87; Kohno, 1957, p. 5, 1964, p. 33 (cited as *L. okamotoi* [sic]).

Paraleuctra gracilis Kawai, 1967, p. 39, fig. 21 A–F. [Holotype ♂ and allotype ♀ (examined; both specimens nearly completely destroyed: Laboratory of Biology, Nara Women's University), Kumogahata, Kyoto Pref., Honshu, Japan.]—Nelson, 1977 p. 250; Zhiltzova, 1976, p. 62; Zhiltzova and Zapekina-Dulkejt, 1986, p. 231. **Syn. nov.**

Okamoto (1922) described this species based on specimens from Hokkaido and western Honshu. Thus it is probable that the syntypes of this species included more than one species. Then Claassen (1936) renamed it because of homonymy. Although Okamoto's description provided insufficient information to discriminate this species, his illustration of the expanded apex of the paraproct agrees with the present material. Furthermore, only the present species, among those similar to *P. okamotoa*, is found in Hokkaido, while four others occur in Honshu. Thus, I herewith designate a male specimen as neotype. It was collected from Sapporo, Hokkaido, one of the localities where the syntypes had been collected. This is necessary in order to clarify the taxonomic status of this species, because I have discovered four closely related species from Honshu.

Okamoto (1922) noted the syntypes were placed in his personal collection, though it is missing today. Neither the syntypes of *Leuctra abdominalis* nor any other name bearing types designated in the same paper (Okamoto 1922) have ever been found at any of the places where Okamoto worked in, i.e., Hokkaido University, Sapporo (through searching by myself), Natural Institute of Agricultural Science and Technology, Suwon (Bae pers. comm. in 1999), and also his home town, Numakuma. Okamoto donated several stonefly specimens to Hiroshima Junior College of Agriculture in 1954. These specimens have currently been housed in the Entomological Laboratory of Hiroshima Prefectural University (Uchida pers. comm.). Seriously damaged syntypes of *Nemoura sachalinensis* Matsumura, 1911, and *N. jezoensis* Okamoto, 1922, have only be detected in the collection.

Kawai (1967) described *P. gracilis* from western Honshu in his monograph on the Japanese Plecoptera. While the types are destroyed and unsuitable for observing any diagnostic features, the paraproct illustrated in the original description agrees well with that of *P. okamotoa*. Kawai (1967) illustrated distinct lateral expansions of the apex of the paraproct, as well as the curved hind margin of tergite 10. Although he also illustrated a female of *P. okamotoa* as a member of *Rhopalopsole*, that was actually a misidentification. According to his illustrations of the prothoracic sternites and female terminalia, the female he examined had the presternite free from the basisternites and a sclerotized area posteriorly on sternite 8. These two features are characteristic of *Rhopalopsole*, but the male illustrated by Okamoto (1922) is easily recognizable as a member of *Paraleuctra* by the enlarged apex of its paraproct.

Description. Macropterous; body generally brown, with darker markings.

Male. Length of body 5.0–6.0 mm; length of forewings 5.0–6.5 mm. Sternites 1–8 uniformly sclerotized. Sternite 9 with a hairy vesicle; subgenital plate widely protruded posteriorly, its hind edge deeply concave medially (Fig. 28). Tergites 1 to 9 weakly sclerotized, but with 4 darker spots in horizontal row and longitudinal darker areas on either side (Fig. 27), and segments 1–3 with membranous field on anterior margins. Tergite 10 forming large, even plate, widely protruding backward and covering posterior part of tergite (Fig. 27), latter forming slender, transverse arms; hind margin of plate gently concave, provided with notch in middle (Fig. 29). Epiproct hook-shaped, apex curved forward to tip (Fig. 28). Cercus simple and slender, apex with blunt, downward-curved knob and small vestige of a more distal segment (Figs 27, 28, 30). Paraprocts extremely elongated along midline, folded and lobed at their apex (Figs 28, 30). Mesial parts of paraproct forming curved, slender stem sclerotized for about three-fourths of its length (Fig. 30). Apex of paraproct expanded on both upper and lower faces; lower expansion more developed than upper one, both located at similar distances from apex (Fig. 30). Small laterally projecting hump located on either side of lower subapical region (Figs 27, 28, 30).

Female. Length of body 5.5–8.0 mm; length of forewings 5.5–8.0 mm. Tergite 1 transversely sclerotized in middle; tergites 2–8 mostly membranous, except for sclerotized areas along midline and on lateral margins, tergite 2 additionally sclerotized along anterior margin. Sternites 1–7 widely sclerotized. Subgenital plate mostly sclerotized except near anterolateral margins of segment; hind margin wide, roundly expanded, shallowly notched medially (Fig. 31). Segment 9 fully sclerotized and forming a ring, segment 10 fully sclerotized dorsally but reduced in size (Fig. 31). Cerci and paraprocts normal (Fig. 31).

Remarks. This species closely resembles the four following species described from Japan in this paper as well as *P. occidentalis*, *P. jewetti* Nebeker and Gaufin, 1966, and *P. rickeri* Nebeker and Gaufin, 1966 from North America. All of them have the mesial part of the paraprocts with a distinctly elongated base and expanded apex, a complete tergite 10, and a conical cercus with an elongate tip. Both the terminalia and the general appearance are very similar among the representatives of each sex in these species.

The male can be separated from the other resembling species by having the hook-like projection of mesial part of the paraproct. Differences from the four new species from Honshu are summarized below in the key to males. The females of the related species are almost indistinguishable and cannot be separated with confidence at the present time. In this paper, I list only the female specimens collected from Hokkaido, where only *P. okamotoa* occurs.

Type specimens. *Neotype.* ♂ (CBM-ZI: #76673): Hokkaido, Sapporo City, Hyakumatsu Stream, 11.v.1993, Y. Sakamaki.

Additional specimens. [Hokkaido] Kumaishi Town, Kenichi River, 27.iii–31.v.1995 (Malaise trap), 37 ♂ 71 ♀; Mori Town, Ojironai River, 18–20.v.1994/7.iv–4.v.1995 (Malaise trap), 2 ♂; Eniwa City, Ichankoppe Stream, 18–20.v.1996 (Malaise trap), 5 ♂ 4 ♀ (CBM-ZI: #76674-82); Akan Town, Chûrui River, 27.iv.1992, 1 ♂; Teshikaga Town, Tokushinushisawa River, 28.iv.1992, 1 ♂; Shimamaki Village, Karibayama, 19.v.1991, 1 ♂ 2 ♀. [Honshu] Aomori Pref., Aomori City, Kasamatsu Pass, 30.v.1990, 1 ♂; Miyagi Pref., Yamato Town, Hatasaka, 27.vi.1991, 1 ♂; Yamagata Pref., Atsumi Village, Atsumi-dake, 24.iii.1993, 6 ♂; Fukushima Pref., Fukushima City, Kuriko Tunnel, 540 m, 1 ♂; Tokyo, Okutama Town, Mizune Stream, 25.iv.1992, 1 ♂; Kanagawa Pref., Yugawara Town, Makuyama, 400 m, 1.v.1991, 1 ♂; Yamanashi Pref., Dôshi Village, Yamabuse Pass, 1200m, 8.iv.1992, 4 ♂; Ishikawa Pref., Kanazawa City, Saikawa Dam, 7.v.1991, 1 ♂; Mie Pref., Komono Town, Yunoyama, 400m, 25.iii.1992, 4 ♂; Hyogo Pref., Takeno Town, Futatsuya, 17.v.1993, K. Inada, 1 ♂; Okayama Pref., Kamisaibara Village, Onbara, 16.v.1993, 2 ♂ (CBM-ZI: #76683-4); Tottori Pref., Kôfu Town, Daisen Mts., 2.v.1992, 4 ♂; Shimane Pref., Shimane Town, Oku-tani, 150 m, 28.iv.1992, 1 ♂. [Shikoku] Tokushima Pref., Kizawa Village, Tsurugi Mts., 1400 m, 3.vi.1991, 4 ♂.

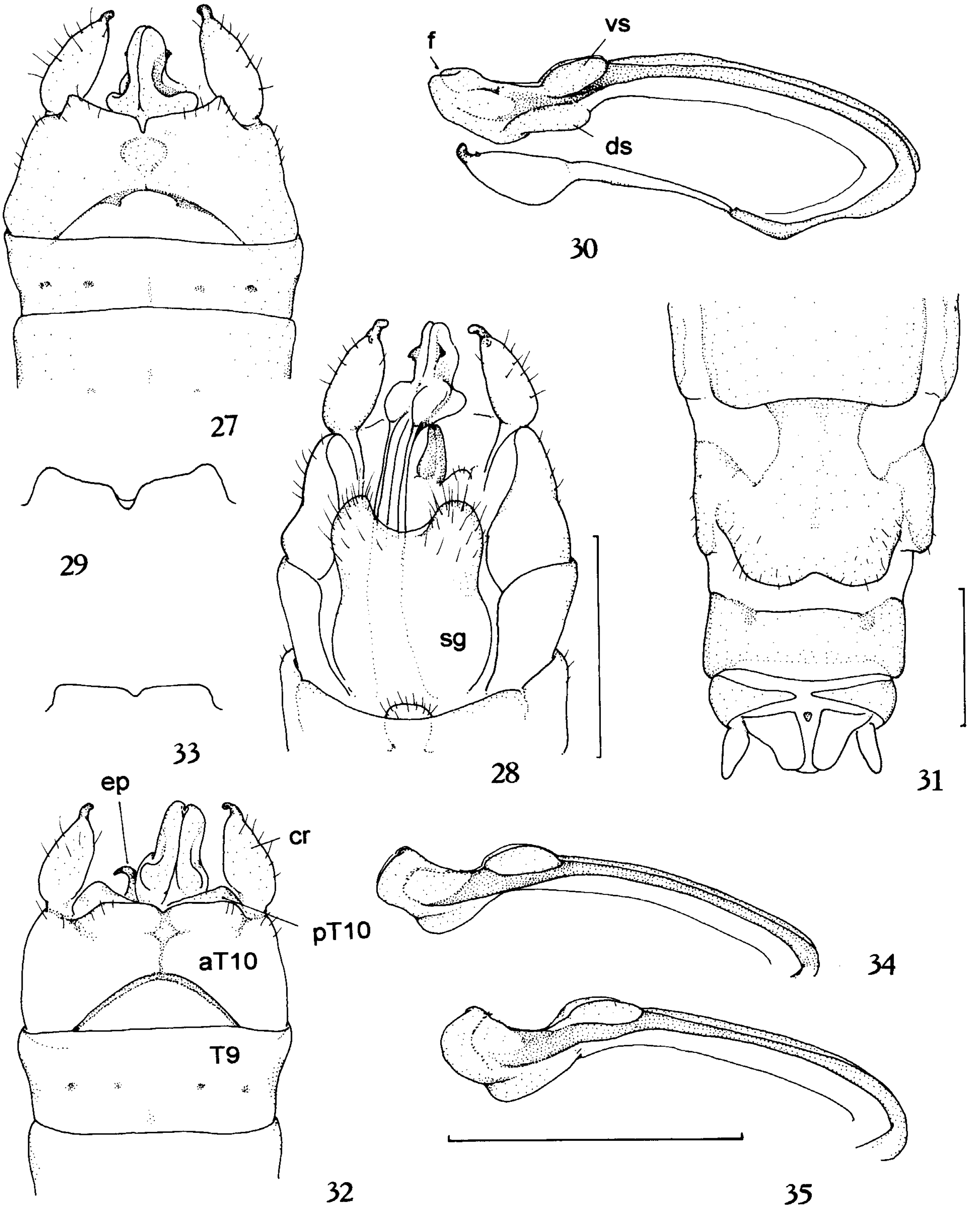
Paraleuctra similis sp. nov.

(Figs 32–35)

Description. Macropterous; body generally brown, with darker markings.

Male. Length of body 5.5–6.0 mm; length of forewings 6.0–7.5 mm. Anterior part of tergite 10 with widely protruding hind margin, which is notched medially (Figs 32, 33). Cercus slender, with strongly sclerotized projection recurving ventrally at tip (Fig. 32); vestige of a more distal segment located on ventral side of projection. Paraprocts extremely elongated along midline, folded and lobed at apex. In profile, apex subquadrate with rounded corners, gently swollen on both upper and lower faces but with lower swelling less developed and located more proximally than upper bulge (Figs 34, 35).

Remarks. The male closely resembles that of *P. okamotoa* in the shape of the



Figs 27–31. *Paraleuctra okamotoa*, male and female (Fig. 31) from Kumaishi Town, Hokkaido: 27 and 28, male terminalia, dorsal and ventral views, respectively; 29, hind margin of tergite 10, dorsal view; 30, paraproct and right cercus, profile; 31, female terminalia, ventral view. Figs 32–35. *Paraleuctra similis*, 32–34, male from Yamagata Pref., and 35 from Miyazaki Pref.: 32, male terminalia dorsal view; 33, hind margin tergite 10, dorsal view; 34 and 35, mesial part of paraprocts, profile. Abbreviations: cr, cercus; ds, dorsal swelling of paraproct; ep, epiproct; f, fold of paraproct; sg, male subgenital plate; T, tergite (aT and pT, anterior and posterior tergites); vs, ventral swelling of paraproct; 9 and 10, 9th and 10th segments. Scales: 0.5 mm; figures are illustrated at the same magnification except Figs 31, 34 and 35. Figs 30, 34, and 35 are illustrated upside-down.

paraproct but differs in having an angulate apex and less swelling of its lower face and in lacking a hook-like subapical projection on the mesial part. Furthermore, the male is separable from that of *P. hokurikuensis*, described below, in having a membranous area on either side of the apex of the paraprocts, whereas the male of the latter species is widely sclerotized on the corresponding area.

Etymology. The specific epithet refers to the close similarity of the new species to *P. okamotoa*.

Type specimens. *Holotype.* ♂ (CBM-ZI: #76685), Honshu, Yamagata Pref., Yonezawa City, Agatsuma Mts., 700–950 m, 19.v.1992, T. Shimizu. *Paratypes.* 3 ♂ (CBM-ZI: #766786-8), collected with holotype.

Additional specimens. [Honshu] Yamagata Pref., Kaminoyama City, Mt. Zaô, 21.v.1992, 1 ♂; Yamagata Pref., Oguni Town, Asahidaira-guchi, 20.v.1992, 1 ♂; Niigata, Asahi Village, Okumiomote, 14–15.v.1996, 2 ♂; Yamanashi Pref., Dôshi Village, Nagamata, 8.iv.1992, 1 ♂; Shizuoka Pref., Mt. Akaishi, Ohi River, 1300 m, 10.iv.1993, 1 ♂; Shizuoka Pref., Misakubo Town, Keta River, 550 m, 10.iv.1993, 2 ♂; Gifu Pref., Kasuga Village, Morimorimura, 12.iv.1998, 1 ♂; Gifu Pref., Kamioka Town, Amabuta-yama, 1040 m, 2.v.1998, 1 ♂; Kamioka Town, Uchiho, 1460 m, 1.v.1998, 1 ♂; Mie Pref., Misugi Village, Hirakura, 400 m, 24.iii.1992, 9 ♂; Mie Pref., Miyagawa Village, Yamato Stream, 3.v.1994, 2 ♂; Osaka Pref., Kawachinagano City, headwaters of Ishi River, 25.iv.1992, 1 ♂; Nara Pref., Higashiyoshino Village, Ohmata, 29.iii.1993, 1 ♂. [Kyushu] Miyazaki Pref., Kitagô Town, Inohae Valley, 5.iii.1994, 1 ♂ (CBM-ZI: #76689).

Paraleuctra hokurikuensis sp. nov.

(Figs 36–38)

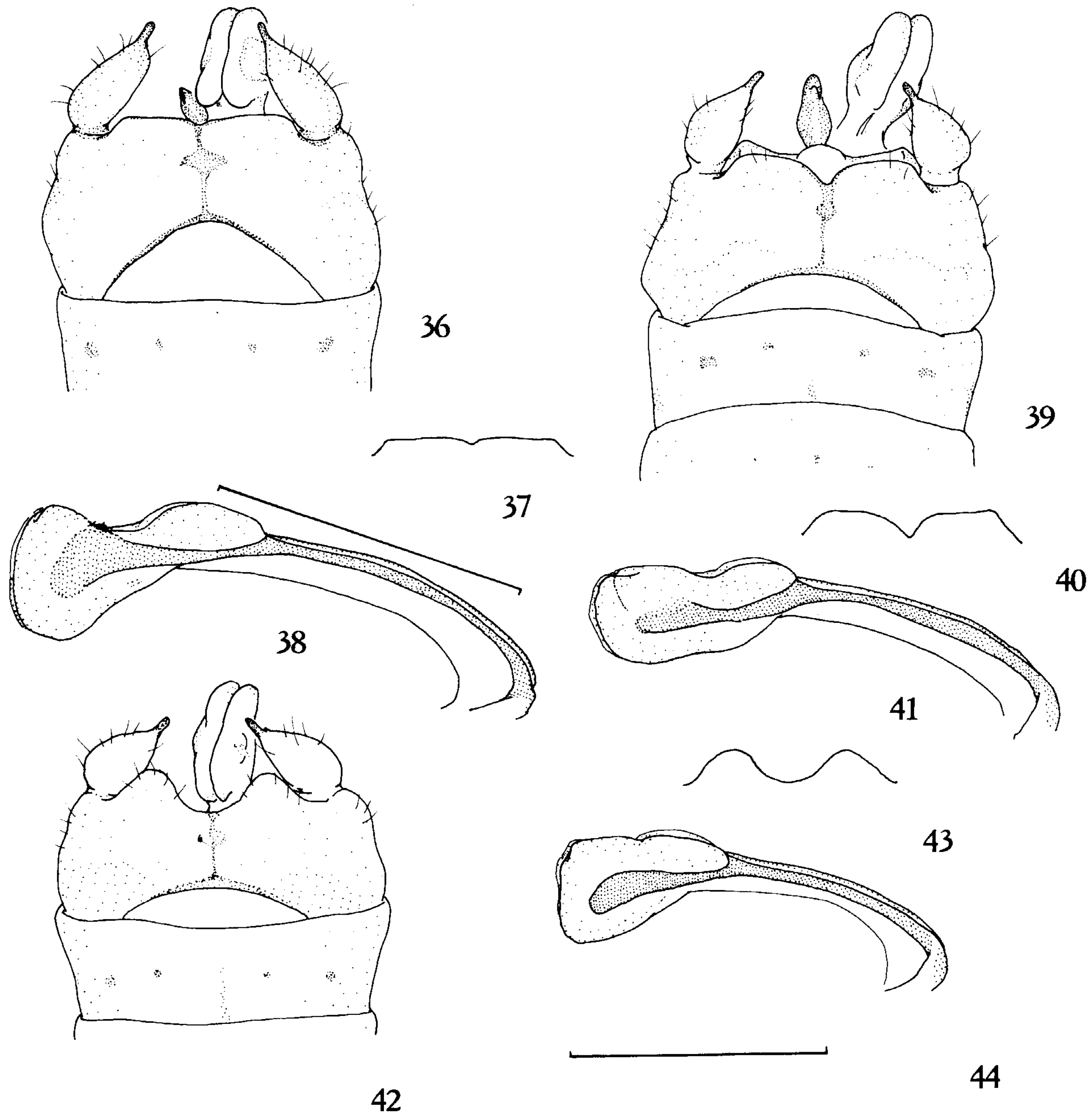
Description. Macropterous; body generally brown, with darker markings.

Male. Length of body 5.5–6.0 mm; length of forewings 5.5–6.5 mm. Anterior part of tergite 10 elongate with deeply concave anterior margin; wide protrusion of hind margin even and weakly notched in middle (Figs 36, 37). Cercus slender, with strongly sclerotized projection recurved ventrally at apex (Fig. 36); vestige of a more distal segment located on ventral side of projection. Mesial portion of paraprocts with enlarged apex, roundly expanded in profile; apex with weak bulge on lower face and setose area anterior to bulge; no lateral expansion of upper face (Fig. 38).

Remarks. This species resembles *P. okamotoa* and *P. similis*. The male differs from both of them in the rounded apex of the paraprocts and by the lack of an expansion on their apex, and also by the very shallow notch on the hind margin of the anterior part of tergite 10.

Etymology. The specific epithet refers to the Hokuriku District of Honshu, which includes Ishikawa Prefecture, where the holotype was collected.

Type specimens. *Holotype.* ♂ (CBM-ZI: #76690), Honshu, Ishikawa Pref., Kawachi Village, Okuike, branch of Naoya River, 8.v.1991, T. Shimizu. *Paratypes.* Honshu: collected with holotype, 6 ♂ (CBM-ZI: #76691-6); Ishikawa Pref., Kanazawa City, Saikawa Dam, 7.v.1991, 1 ♂; Gifu Pref., Kiyomi Village, Maze River, Naratani, 920 m, 3.v.1992, 1 ♂; Gifu Pref., Kasuga Village, Morimorimura, 12.iv.1998, 1 ♂.



Figs 36–38. *Paraleuctra hokurikuensis*, male from Yamagata Pref., Honshu: 36, male terminalia, dorsal view; 37, hind margin of tergite 10, dorsal view; 38, mesial part of paraprocts, profile. Figs 39–41. *Paraleuctra angulata*, holotype: 39, male terminalia, dorsal view; 40, hind margin of tergite 10, dorsal view; 41, mesial part of paraprocts, profile. Figs 42–44. *Paraleuctra concava*, male from Yamagata Pref.: 42, male terminalia, dorsal view; 43, hind margin of tergite 10, dorsal view; 44, mesial part of paraprocts, profile. Scales: 0.5 mm; figures are illustrated at the same magnification except Fig. 38. Figs 38, 41, and 44 are illustrated upside-down.

Paraleuctra angulata sp. nov.
(Figs 39–41)

Description. Macropterous; body generally brown, with darker markings.
Male. Length of body 5.5–6.0 mm; length of forewings 5.0–5.5 mm. Anterior part

of tergite 10 with pair of angulate protrusions of hind margin, with deep medial notch between them (Figs 39, 40). Cercus conical, with strongly sclerotized, ventrally recurved projection at apex (Fig. 39), vestige of more distal segment located on ventral side of projection. Mesial portion of paraprocts with subquadrate apex in profile, with no real swellings; apex folded on lower side of apical corner (Fig. 41).

Remarks. This species resembles *P. concava* sp. n., described below. The male differs from it in the truncate projections of the hind margin of the anterior part of tergite 10. The mesial part of the paraprocts has its apex folded on the upper side of the distal corner, whereas in *P. concava* the fold is found on the apical side, as in the other three resembling species from Japan, *P. okamotoa*, *P. similis* and *P. hokurikuensis*.

Etymology. The specific epithet refers to the shape of the apex of the mesial part of the paraprocts, which has angulate corners in lateral view.

Type specimens. *Holotype.* ♂ (CBM-ZI: #76697), Honshu, Iwate Pref., Isawa Town, Ara and Kanayama Streams, 600–700 m, 9–12.vi.1997, T. Shimizu. *Paratype.* Honshu: Gifu Pref., Shirotori Town, Amidagataki Waterfall, 650 m, 5.iv.1998, 1 ♂ (CBM-ZI: #76698).

Paraleuctra concava sp. nov.

(Figs 42–44)

Description. Macropterous; body generally brown, with darker markings.

Male. Length of body 6.0–7.0 mm; length of forewings 6.0–7.5 mm. Anterior part of tergite 10 with pair of roundly protrusions of hind margin (Figs 42, 43). Cercus rounded, with strongly sclerotized, ventrally recurved projection at apex (Fig. 42); vestige of a more distal segment located on ventral side of projection. Mesial portion of paraprocts with enlarged apex, subtriangular with rounded corners in profile; apex dilated dorsoventrally and truncate, with fold on distal side of apical corner (Fig. 44).

Remarks. This species resembles the three preceding species. The male differs from those of the other species in having a wide indentation of the hind margin of the anterior part of tergite 10 and a dilated apex of the mesial part of the paraprocts.

Etymology. The specific epithet refers to the concave outline of the hind margin of tergite 10.

Type specimens. *Holotype.* ♂ (CBM-ZI: #76699), Honshu, Fukushima Pref., Yamato Town, Kawairi, Misawa Lodge, 13.vi.1996, T. Shimizu. *Paratypes.* Honshu: Miyagi Pref., Yamato Town, Hatasaka, 27.vi.1991, 1 ♂ (CBM-ZI: #76700); Yamagata Pref., Oguni Town, Asahidairaguchi, Hannari Lodge, 20.v.1992, 2 ♂ (CBM-ZI: #76701–2); Yamanashi Pref., Dôshi Village, Yamabuse Pass, 8.iv.1992, 2 ♂; Nagano Pref., Minamimaki Village, Yu River, 1300 m, 6.v.1990, 1 ♂; Gifu Pref., Shirotori Town, Amidagataki Fall, 640 m, 5.iv.1998, 1 ♂; Mie Pref., Komono Town, Mt. Yunoyama, 400m, 25.iii.1992, 1 ♂; Okayama Pref., Kamisaibara Village, Onbara, 16.v.1993, 1 ♂; Tottori Pref., Kôfu Town, Mt. Daisen, Jadani Stream, 800 m, 2.v.1992, 1 ♂.

Key to Asian species of *Paraleuctra*
Males

1. Cercus forked, with a tapered ventral arm (Figs 7, 13, 19–21) 2

–. Cercus simply conical, bearing a curved projection at apex (Figs 27, 28, 30, 32, 36, 39, 42): *P. occidentalis* group 6

2. Segment 9 forming a ring with no distinct subgenital plate (Fig. 5); sternite 9 protruded in middle of hind margin: *P. purcellana* group .... *P. ezoensis* sp. n., Japan

–. Segment 9 interrupted ventrally by distinct subgenital plate (Figs 11, 28) 3

3. Apterous; subgenital plate subquadrate (Fig. 11) .... *P. ambulans* sp. n., Japan

–. Winged; subgenital plate tapered, with concave hind margin: *P. cercia* group ... 4

4. Cercus with a small, knob-like projection on ventral arm .... *P. cercia*, Russian Far East and Japan

–. Cercus with no outgrowth on either dorsal or ventral arm 5

5. Dorsal arm of cercus almost same length as ventral one .... *P. orientalis*, China/*P. tetraedra*, Himalayas

–. Dorsal arm of cercus distinctly longer than ventral one, with bifurcate tip .... *P. zapekinae*, Russian Far East

6. Mesial part of paraprocts with lateral expansion on upper face of apex (Figs 30, 34, 35) 7

–. Mesial part of paraprocts with almost parallel sides on upper face of apex (Figs 38, 41, 44) 8

7. Tergite 10 with almost even hind margin (Fig. 33) .... *P. similis* sp. n., Japan

–. Tergite 10 with gently arched hind margin (Fig. 29) .... *P. okamotoa*, Sakhalin and Japan

8. Mesial part of paraprocts forming rounded apex in profile (Fig. 38), cercus slender (Fig. 36) .... *P. hokurikuensis* sp. n., Japan

–. Mesial part of paraprocts forming angulate apex in profile (Figs 40, 43), cercus robust (Figs 39, 42) 9

9. Tergite 10 with deep notch in middle of hind margin (Fig. 40); mesial part of paraprocts with apical fold opened to lower face (Fig. 41) .... *P. angulata* sp. n., Japan

–. Tergite 10 deeply arched in middle of hind margin (Fig. 43); apex of mesial part of paraprocts with apical fold opened to distal face (Fig. 44) .... *P. concava* sp. n., Japan

Females

1. Apterous .... *P. ambulans*

–. Winged 2

2. Subgenital plate extended in middle of hind margin (Fig. 6): *P. purcellana* group .... *P. ezoensis*

–. Subgenital plate widely expanded posteriorly (Figs 22, 31) 3

3. Subgenital plate poorly sclerotized, hind margin weakly bilobed (Fig. 31): *P. occicidentalis* group including *P. angulata*, *P. concava*, *P. hokurikuensis*, *P. okamotoa*, and *P. similis*, undeterminable

–. Subgenital plate well sclerotized and dark, hind margin distinctly bilobed (Fig. 22): *P. cercia* group 4
4. Subgenital plate with rounded hind margin on either side of medial cleft .... *P. orientalis/P. tetraedra*
–. Subgenital plate with angulate hind margin on either side of medial cleft 5
5. Subgenital plate with tapered posterolateral margins ....*P. zapekinae*
–. Subgenital plate with almost parallel sides ....*P. cercia*

New Combinations in the Japanese Leuctridae

1) *Rhopalopsole elongata* (Kawai, 1967), **comb. nov.**

Kawai (1967) described *Paraleuctra elongata* based on females from Nagano and Kyoto, Honshu, and illustrated the female subgenital plate with a protruding hind margin. This feature is present only in *Rhopalopsole* among all genera of Leuctridae. The holotype and paratypes of this species have been completely destroyed, although the label was discovered at Nara Women's University.

2) *Perlomyia nipponica* (Okamoto, 1922), **comb. nov.**

Leuctra nipponica was originally described by Okamoto (1922) on the basis of several specimens from Hokkaido and Honshu, and Kawai (1967) transferred it to *Paraleuctra*. Okamoto (1922) illustrated the female of *L. nipponica* as having sternite 8 with median sclerites separated along the midline. This feature is one of the distinctive characters of *Perlomyia* according to Zwick (1977). Unfortunately, the syntypes are missing.

3) *Perlomyia gifuensis* (Kohno, 1965), **comb. nov.**

Kohno (1964) proposed *Rhopalopsole gifuensis* in a checklist and described it later in a reference book (Kohno 1965). The latter description was overlooked by succeeding authors, and this species has been treated as *nomen nudum* although it is available. Kohno (1965) illustrated the elongated apex of the male subgenital plate and the pointed male cerci. These features are characteristic of *Perlomyia* and not of *Rhopalopsole* (see Zwick 1977). She did not designate any types.

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